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Volume 2, WELDING FABRICATION PROCEDURE

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RECORD OF REVISIONS

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0	8/16/04	Initial issue.	Kelly Bingham, <i>FWO-DECS</i>	Gurinder Grewal, <i>FWO-DO</i>

**Responsible Engineering Standards POC and Committee
for upkeep, interpretation, and variance issues**

WFP 2-06	<u>Welding POC/Committee</u>
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WFP 2-06 AWS D1.3/9.1, SHEET METAL WELDING

1.0 PURPOSE AND SCOPE

- A. This welding procedure shall govern the welding of components to the requirements of AWS D1.3/9.1 (Reference 1 and 2). The Code edition and addenda for this procedure shall be the latest in effect or as otherwise specified by engineering requirements.
- B. The use of AWS Standard Welding Procedure Specifications (WPS) shall be in accordance with GWS 1.02, Administrative Control of Welding.

2.0 REFERENCES

- 1. AWS D1.3, "Welding Sheet Steel in Structures"
- 2. AWS D9.1, "Welding of Sheet Metal"

3.0 WELDER QUALIFICATION

- A. Welder/welding operators shall be currently certified, having performed qualification tests in accordance with GWS 1-05, *Welder Performance Qualification & Certification*.

4.0 WELDING PREREQUISITES

- A. All welding shall comply with the requirements specified in the Welding Procedure Specification (WPS) or Welding Technique Sheet (WTS).
- B. Welding shall not be performed when the ambient temperature in the immediate vicinity of the weld is lower than 0 °F or when surfaces are wet or exposed to rain, snow, dust, or high wind. The additional preheat should be applied if there is suspicion of moisture being present. Enclosures shall be erected to protect the items being welded where required. The welder and weld joint shall be sufficiently protected from inclement conditions.

5.0 MATERIALS

- A. Base Materials
 - 1. Only the materials specified in the WPS or WTS may be welded using this procedure.
- B. Filler Materials
 - 1. Welding filler materials to be used with this procedure are specified in the WPS or WTS. A listing of applicable welding filler materials is provided in GWS 1-07, *Material Specifications*.
 - 2. Requirements for the purchase and control of welding filler material shall be in accordance with GWS 1-03, *Welding and Brazing Material Procurement and Control*.
 - 3. Welders making weldments with this procedure must utilize welding filler materials (electrodes, bare filler wire, etc.). Welders shall not perform welds autogenously unless other wise directed by the WPS or WTS.

6.0 BASE MATERIAL JOINT PREPARATION

- A. Surfaces and edges to be welded shall be reasonable smooth, uniform, and free from fins, tears, cracks, and other discontinuities that would adversely affect the quality or strength of the weld.
- B. Members to be joined may be cut to shape and size by machining, shearing, chipping, grinding, thermal cutting, or air carbon arc gouging.
- C. All carbon- arc, oxygen and plasma arc surfaces shall be ground back to bright, sound material.

7.0 BASE MATERIAL JOINT CLEANING

- A. Prior to welding, surfaces for welding shall be clean and free from paint, oil, rust, scale, slag, grease, and other foreign materials that are detrimental to welding.
- B. Material shall be cleaned prior to welding. Cleaning methods may include, but not limited to, solvents, wire brushes, power grinders, and power wire brushes. Solvents which may be used on the base material and weld materials are methyl alcohol, ethyl alcohol, isopropyl alcohol, acetone, methyl ethyl ketone, toluene, Varson 4, Dowanol EB, and Stoddard solvents.

8.0 JOINT FIT-UP AND ALIGNMENT

- A. All weld joints shall be visually examined before welding to ensure conformance to GWS 1-06, Weld Joint Design, drawings, and code requirements (Reference 1 and 2).
- B. No fillers are allowed such as spacers or slugs.
- C. The root opening and fit-up tolerances shall be as specified in GWS 1-06, Weld Joint Design or engineering drawings.
- D. The parts to be joined by a tee or fillet weld shall be brought into as close contact as is practicable to facilitate complete fusion between the parts being joined.
- E. Members to be welded shall be brought into correct alignment and held in position by bolts, clamps, wedges, other suitable devices or tack welded until welding has been completed. The use of jigs and fixtures is recommended where practicable. The degree of angle on the perpendicular member of the joint shall be as specified in engineering standards/documents or drawings.
- F. The gap, mismatch, and other requirements shall be in accordance with References 1 and 2 as applicable.
- G. Fit-up criteria are important in sheet metal welding because of the thickness (light gage) of the base material. Gaps that can occur from cutting or poor fit-up may cause molten weld metal to fall through. This problem is significantly magnified when welding out of position. Because of the thin base material being welded, tacks or clamping devices must be placed close together to prevent warping during final welding.

9.0 PREHEAT

- A. When the base material temperature is below the minimum preheat temperature specified in the WPS or WTS for AWS D1.3 or AWS D9.1 applications, the base material shall be heated such that the surfaces to be welded are at or above the minimum preheat temperature prior to welding. Care should be taken to avoid distortion that could affect fit-up or cause tack welds to crack.
- B. Lower temperature deviations are permitted for arc spot, seam, and plug welding application when the welding variables such as amperage, travel speed and weld time are adjusted in accordance with the code.
- C. Preheat temperature above 125 F° shall be checked by a surface pyrometer, “Tempilstik,” or nonmercury-type thermometer. Temperature indicating crayons shall not be used directly in the weld zone.

10.0 TACK WELDS

- A. Tack welds shall be made by a qualified welder in accordance with an approved WPS or WTS.
- B. Acceptable tack welds may be incorporated into the final weld.
- C. Defective tack welds shall be removed or repaired prior to welding.

11.0 BACKPURGES

Not applicable.

12.0 INTER-PASS TEMPERATURE (IPT)

- A. Stainless steel shall not be allowed to exceed 350 F°..

13.0 WELDING TECHNIQUE

- A. Welding voltage and amperage shall be in accordance with the limits specified in the WPS or WTS. Voltage and amperage range gages located on the welding power supply are for reference only and are not mandatory check or hold points. Voltage and amp range checks for documentation purposes shall be performed by a qualified (CWI or equivalent) inspector using calibrated voltage and amp meters or approved welding parameter recording equipment.
- B. Filing, grinding, chipping, may be required before depositing the next bead to remove cracks or other unacceptable defects that appear on the surface of a weld bead.
- C. Before welding over previously deposited material, all slag and flux shall be removed, and the weld and adjacent base material within 1” on either side of the weld, shall be brushed clean.
- D. Control of Distortion and Shrinkage
 - 1. Members to be welded shall be brought into correct alignment and held in position by bolts, clamps, wedges, other suitable devices or tack welded until welding has been completed. The use of jigs and fixtures is recommended where practicable.

2. In assembling and joining parts or in welding reinforcing parts to members, the procedure and sequence shall be minimize distortion and shrinkage.
 3. The welding sequence applied, in conjunction with the WPS or WTS and overall fabrication methods, shall produce sheet steel products meeting the specified quality requirements.
 4. In making welds under conditions of severe external shrinkage restraint, the welding shall be continuous to completion or to a point that will ensure freedom from cracking before the joint is allowed to cool below the minimum specified preheat temperature.
- E. Welding shall be performed single arc unless otherwise specified in the WPS or WTS.
- F. Welding processes permitted with this WFP; SMAW, GMAW-SC (Pulse/no Pulse), and GTAW.

14.0 INSPECTOR QUALIFICATION

- A. The Inspector who performs welding inspection for acceptance to this procedure shall be authorized by the LANL WPA.

15.0 ACCEPTANCE CRITERIA FOR COMPLETED WELDS

- A. Butt Welds
1. As-welded surfaces are permitted; however, the surface of welds shall be sufficiently free from coarse ripples, grooves, overlaps, abrupt ridges, and valleys.
 2. Weld profiles shall be in accordance with the requirements of Reference 2.1 and 2.2.
 3. Undercut
 - AWS D1.3 - The cumulative length of undercut shall be no longer than $L/8$, where L is the specified length of weld or in the case of spot welds, the circumference, provided fusion exists between the weld material and the base material. Depth of the undercut is not subject of inspection and need not be measured. Melt- through that result in a hole is unacceptable.
 - AWS D9.1 - undercut may not exceed $0.15t$ when the base material thickness being welded is 0.187 in. or thinner, or exceed $0.25t$ when the base material being welded is greater than 0.187 in.
 4. Reinforcement shall not exceed $1/8$ in height and shall have gradual transition to the plane of the base material surface.
 5. Porosity or Inclusions
 - One visible pore or inclusion no larger than $0.5t$ is permitted in any 1 in. of weld, where t equals the thickness of the thinner member.
 - Three visible pores or inclusions no larger than $0.25t$ are also permitted in any 1 in. of weld, where t equals the thickness of the thinner member
 6. Complete fusion shall be obtained.
 7. Joint penetration shall be as specified by the engineering documents.

B. Fillet Welds

1. As-welded surfaces are permitted; however, the surface of welds shall be sufficiently free from coarse ripples, grooves, overlaps, abrupt ridges, and valleys.
2. Fillet welds may vary from concave to convex, with the maximum convexity not to exceed 1/8 in. The size of a fillet weld is determined by drawing requirements. Profiles shall be in accordance with Reference 1 and 2.
3. Visual acceptance criteria for fillet welds as described above in 15.1. 3, 15.1.5, 15.1.6, and 15.1.7.

C. Arc Strikes

1. Cracks or blemishes outside of the area of permanent welds resulting from arc strikes shall be ground to a smooth contour and checked to ensure soundness.

16.0 WELD REPAIRS

- A. Weld repairs shall be performed using the original WPS or WTS or an alternate WTS specific to repair or to restore a weld to an acceptable condition.
- B. Unacceptable portions of the weld shall be removed by machining, grinding, chipping, or air carbon arc gouging. The repaired area or surfaces shall be cleaned thoroughly before welding.
- C. The repaired weld shall be reexamined by the method originally used, and the same technique and quality acceptance criteria shall be applied.

17.0 POST WELD HEAT TREATMENT

Not applicable.

18.0 ATTACHMENT WELDS

- A. Materials used for welded attachments shall be compatible with the base material. Welds used to join attachment to base material shall be in accordance with an approved WPS or WTS.
- B. When the specification requires temporary attachments to be removed, a method of removal that will not damage the base material shall be utilized; i.e., cut, grind, or air carbon arc gouge the attachment off and grind the area flush.

19.0 ATTACHMENTS

None